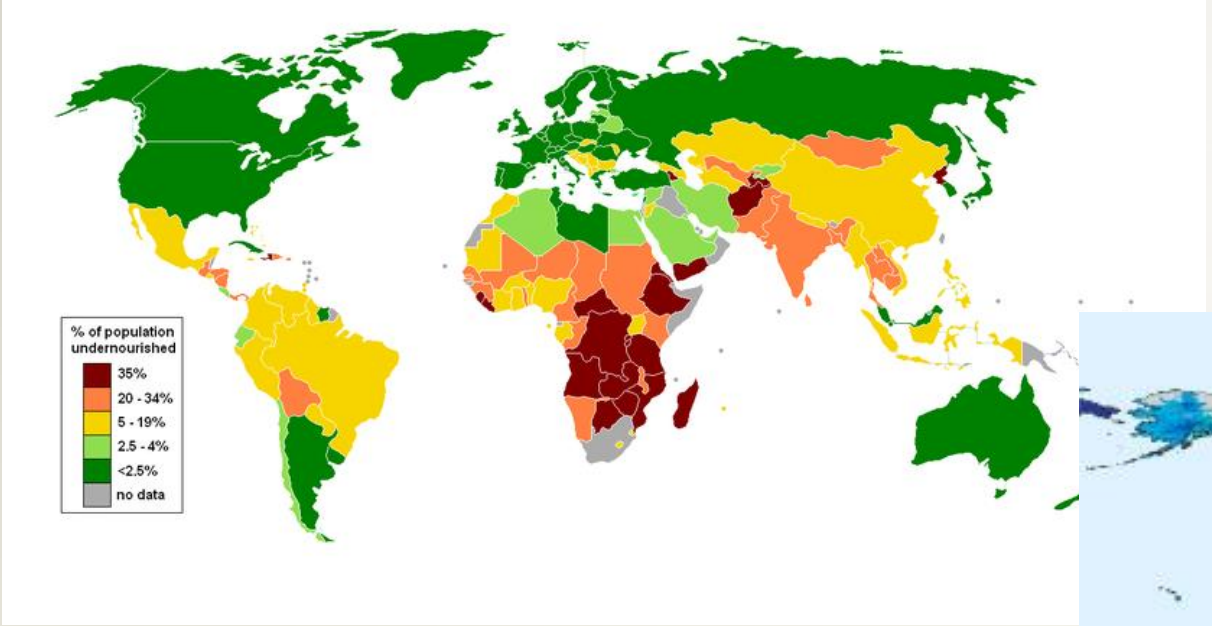
GEOSPATIAL TECHNOLOGIES IN SUSTAINABLE WATER MANAGEMENT IN AGRICULTURE

Elizaveta Khazieva

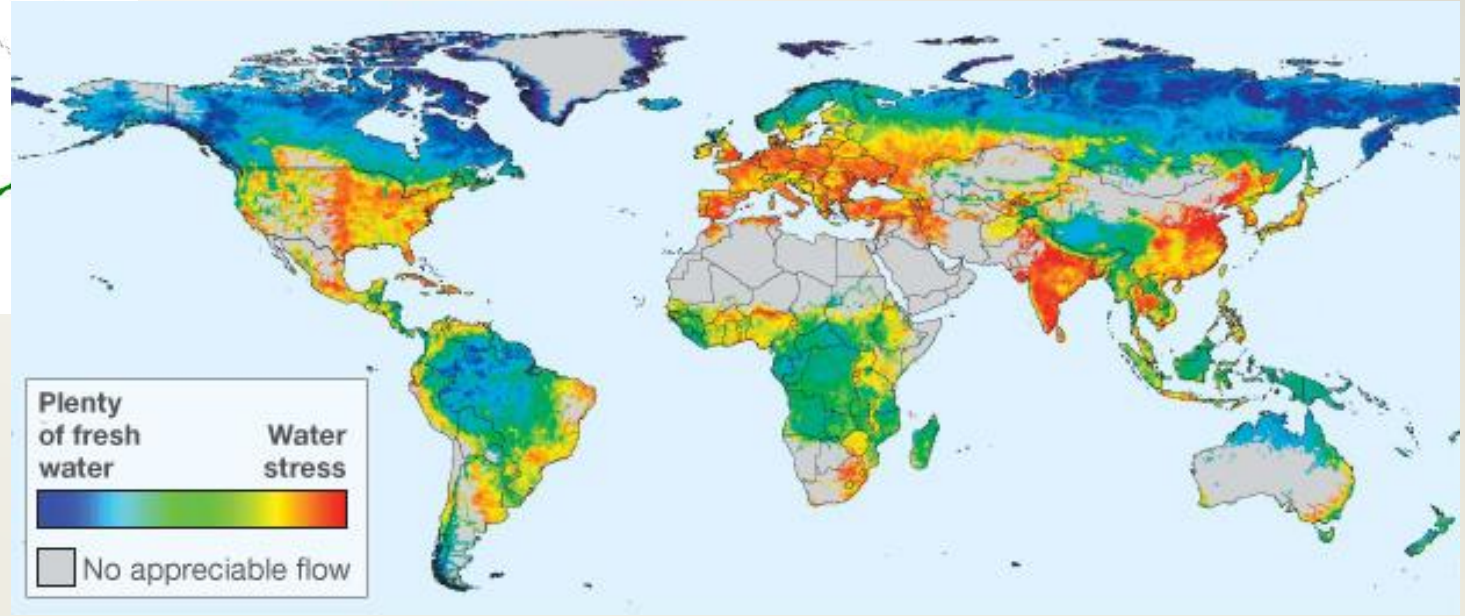
CEU CENTRAL EUROPEAN UNIVERSITY

Agriculture and Food security

Map depicting the percentage of global undernourishment, 2008



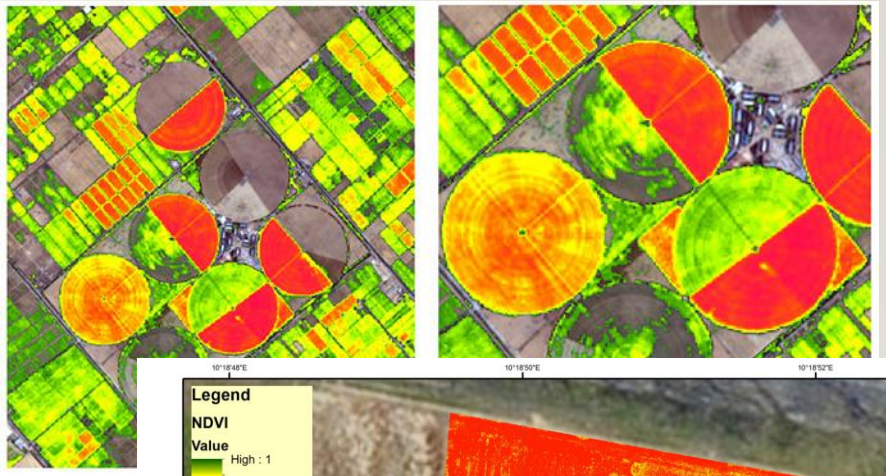
Global Water supply



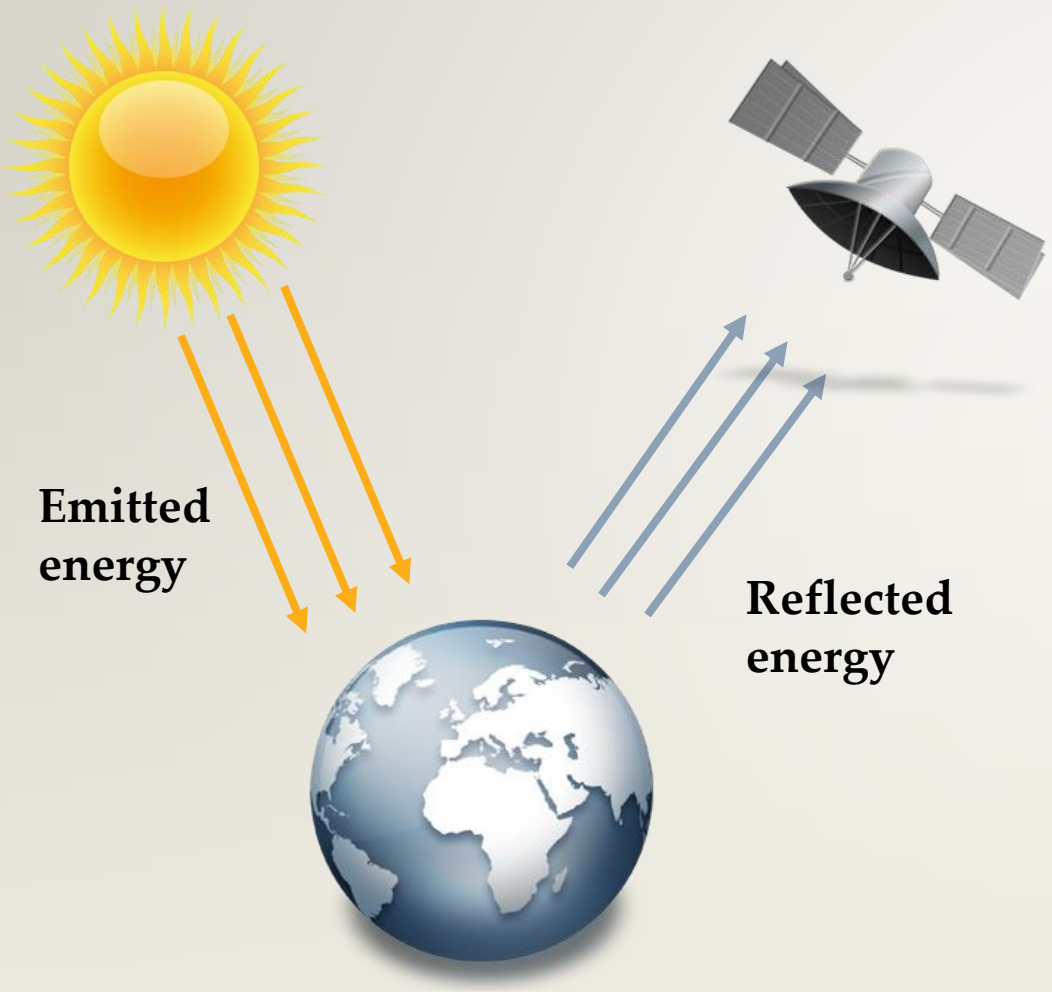
Geospatial technologies for agricultural management

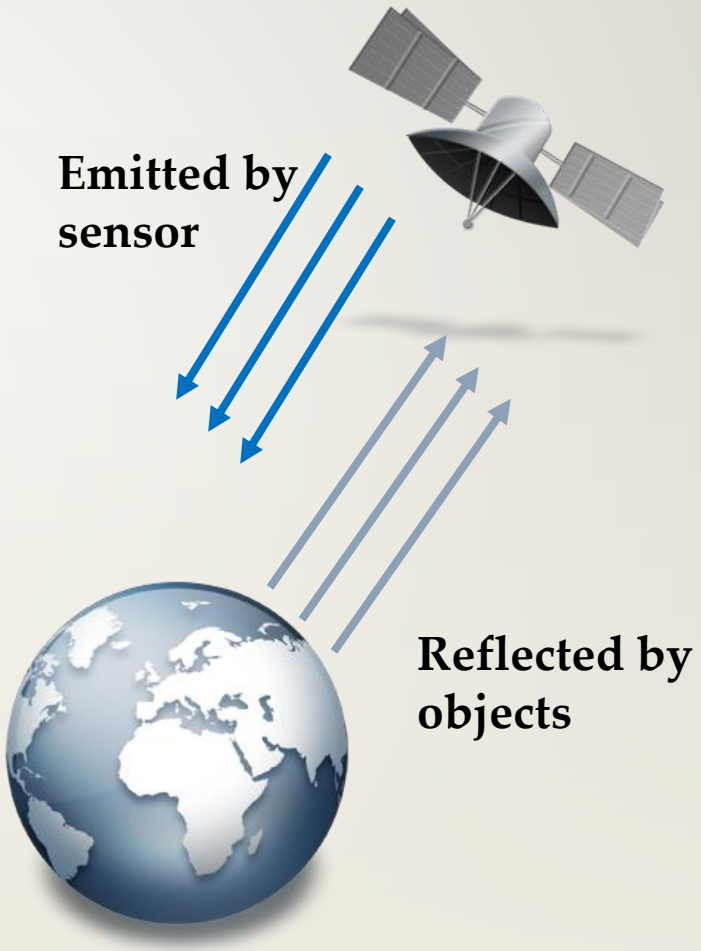
- Crop identification
- Crop condition assessment
  - **Early detection, diagnosis of plant diseases**
  - **Nutrient deficiency diagnostics**
  - **Water stress assessment**

- Soil moisture estimation
- Irrigation planning
- Crop yield estimation
- Crop yield forecasting
- Precision agriculture



Passive vs active remote sensing





Potential data sources

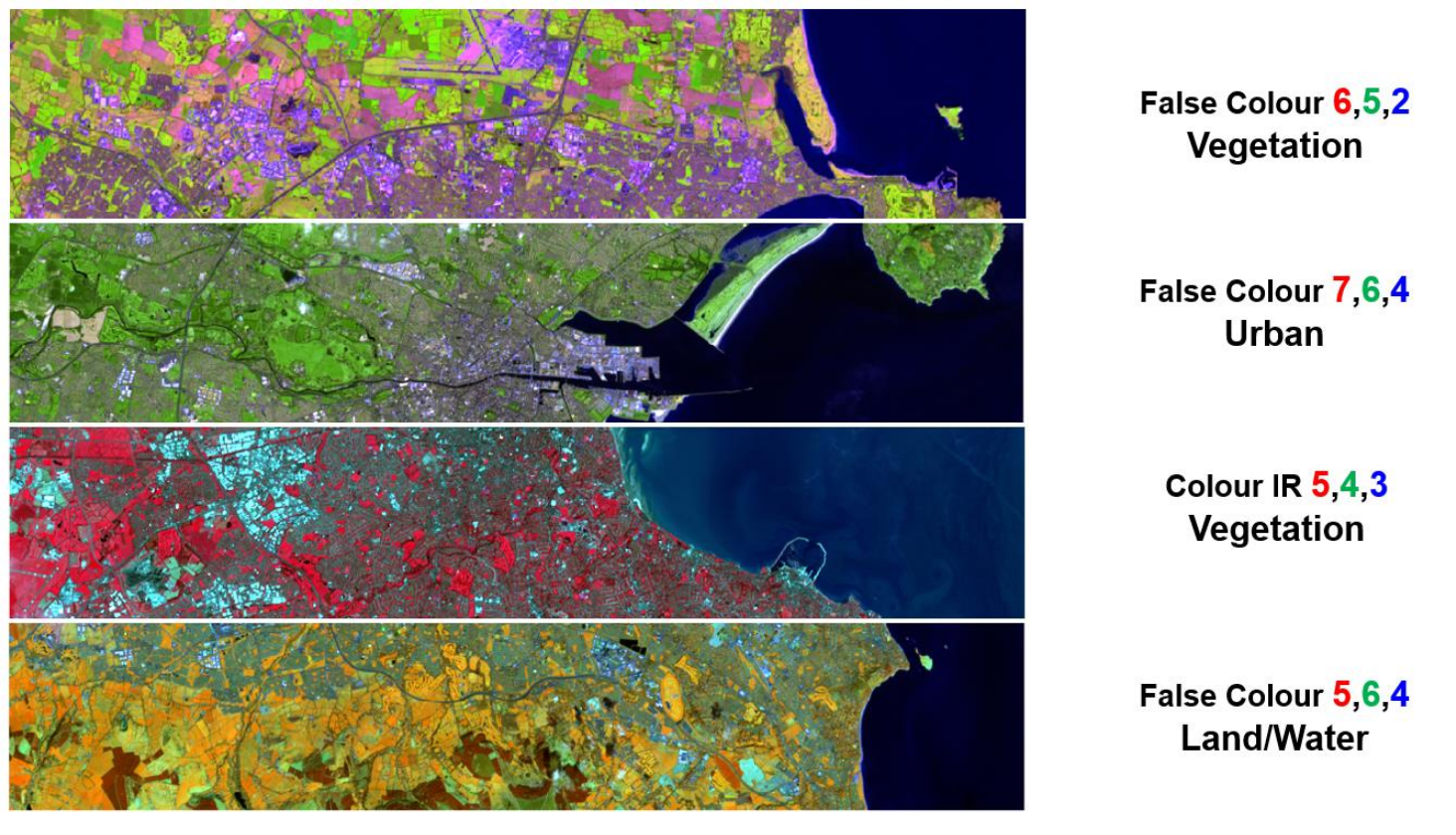
Data (active)	*Description*	*Source*
ALOS PALSAR	5 modes (spatial resolution - from 7 m to 100 m.)	http://www.eorc.jaxa.jp/ALOS/en/gallery/new_arr.htm
Cosmo-SkyMed 1, 2, 3, 4	5 modes (spatial resolution - from 1 m to 100 m.)	http://www.e-geos.it/cosmo-skymed.html
Sentinel-1A	4 modes (spatial resolution - from 4 m to 80 m.)	https://scihub.copernicus.eu/dhus/#/home
Radarsat – 2	18 modes (spatial resolution - from 1 m to 100 m.)	http://www.asc-csa.gc.ca/eng/satellites/radarsat/radarsat-tableau.asp
Envisat	3 modes (spatial resolution - from 30 m to 1000 m.)	https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/ers
TerraSAR-x	7 modes (spatial resolution - from 0.25 m to 40 m.)	http://terrasar-x-archive.infoterra.de/
Pleiades	4 spectral bands (spatial resolution - from 0.5 m to 2 m)	http://www.intelligence-airbusds.com/pleiades/

Passive (optical) sensors

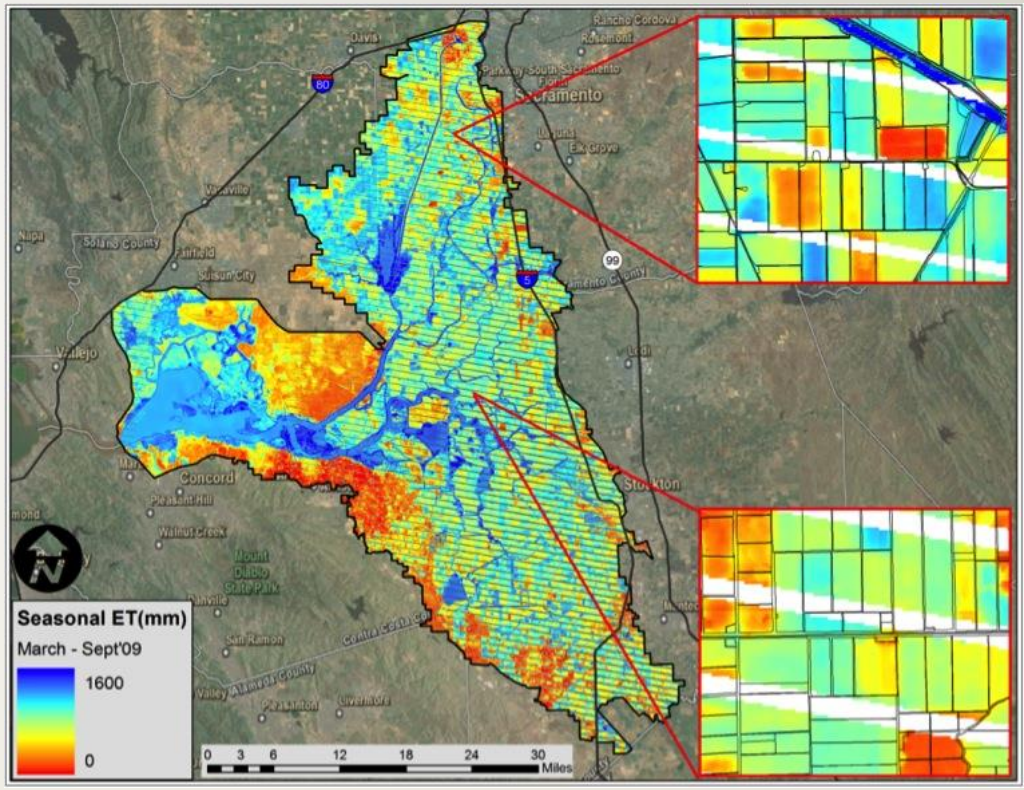
Spectral bands combinations

Natural color image vs false color image

Spectral bands combinations

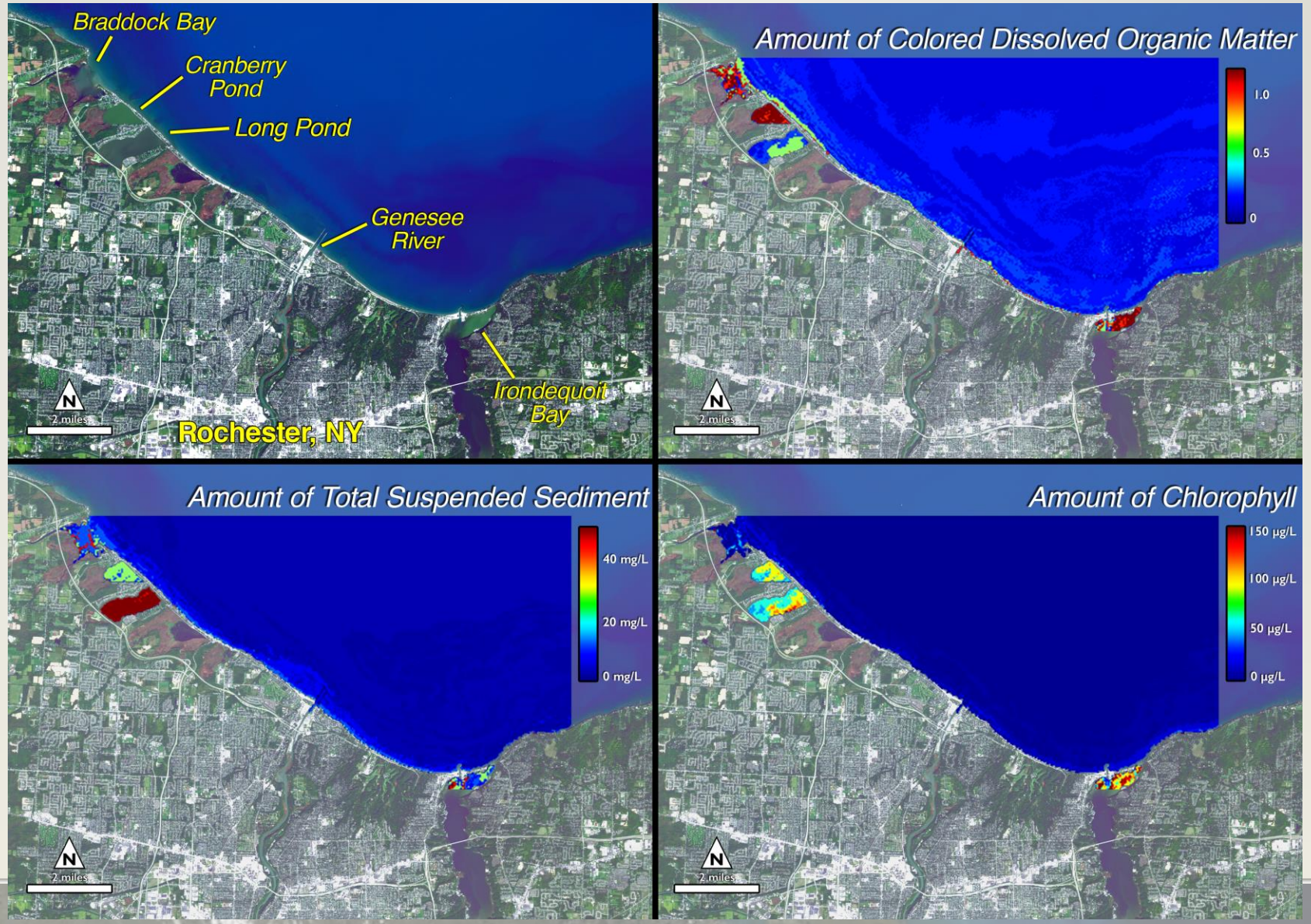


Landsat band combinations



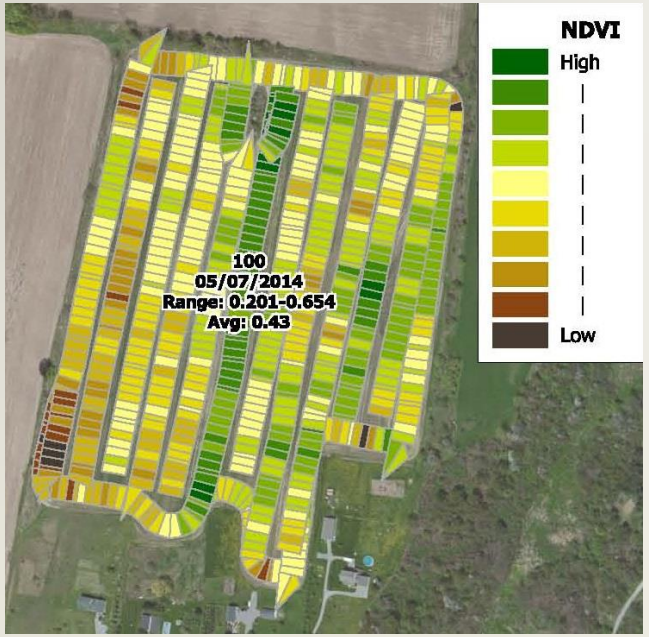
Seasonal evapotranspiration crop growing season

Coastal water quality

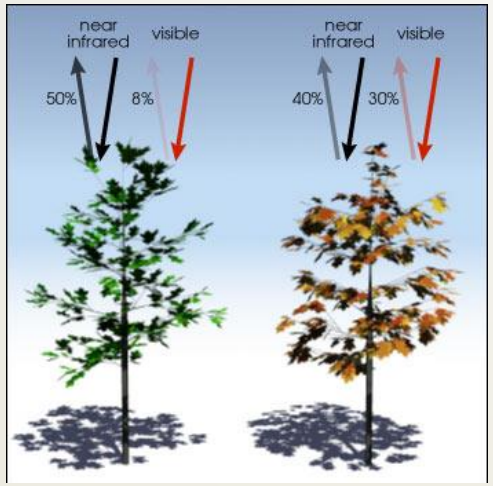


Indices for vegetation health assessment

NDVI
(Normalized Difference Vegetation Index)

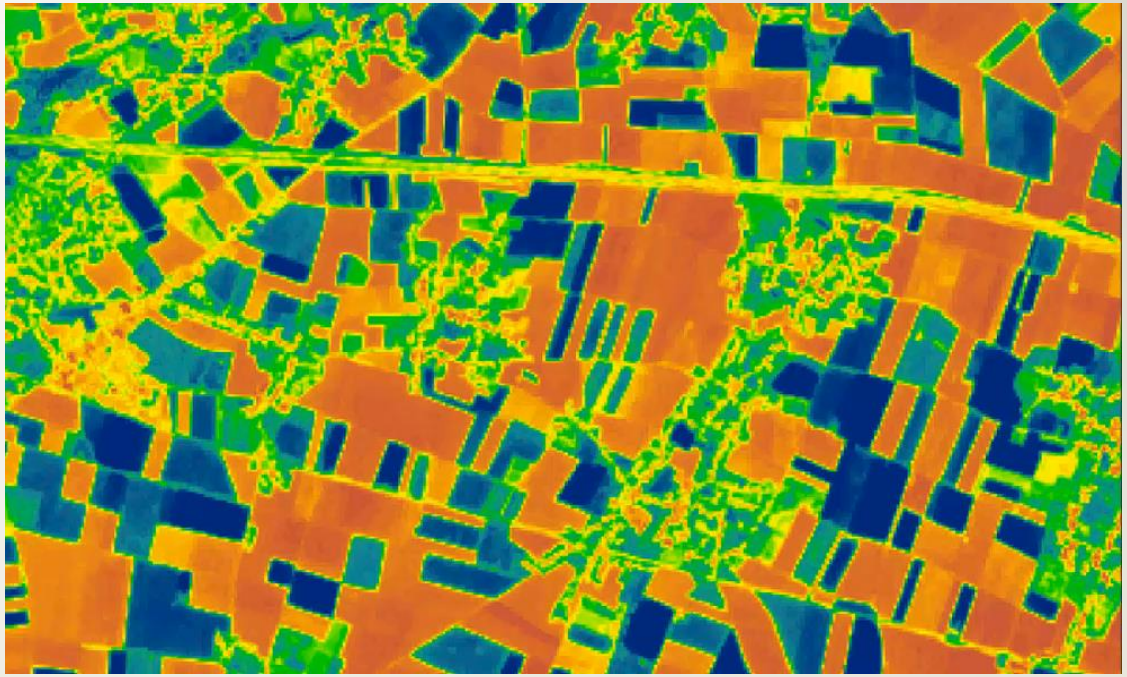


$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$



NDWI
(Normalized Difference Water Index)

$$NDWI_t = \frac{NIR_t - SWIR_t}{NIR_t + SWIR_t}$$

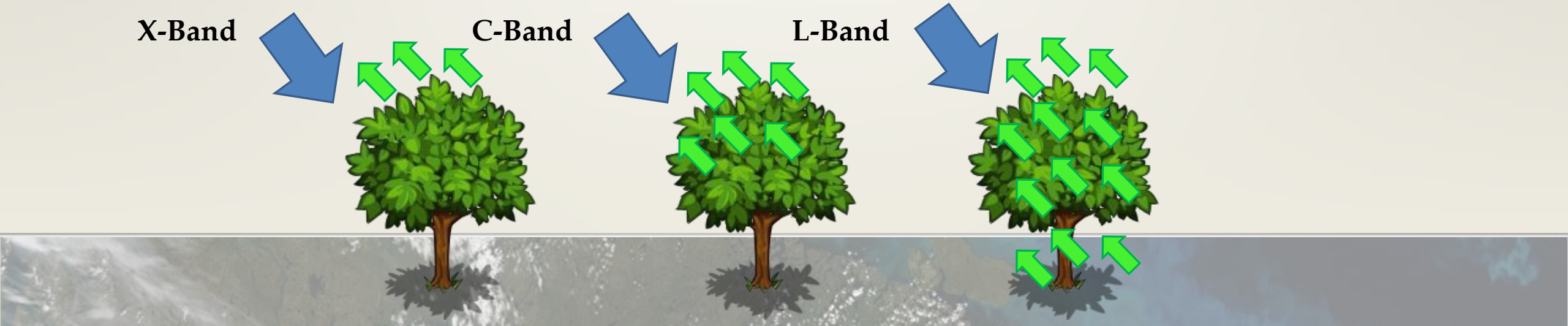


NDWI evolution from May to September

Active sensors

Commonly Used Frequency Bands

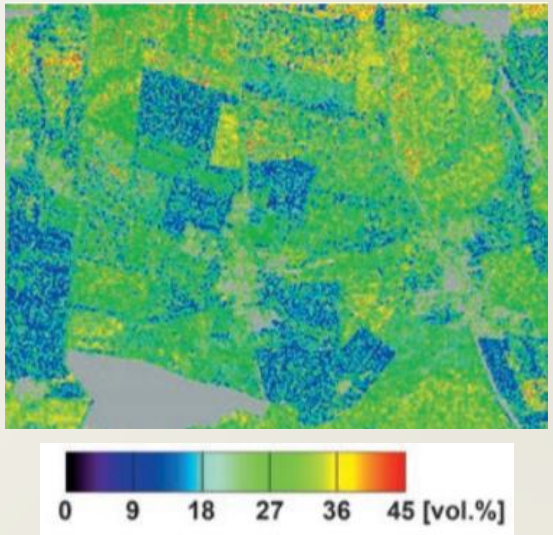
Frequency band	Frequency range	Application Example
P-Band	300 Mhz – 1 GHz	biomass, soil moisture, penetration
L-Band	1 GHz – 2 GHz	agriculture, forestry, soil moisture
C-Band	4 GHz – 8 GHz	ocean, agriculture
X-Band	8 GHz – 12 GHz	agriculture, ocean, high resolution radar
Ku-Band	14 GHz – 18 GHz	glaciology (snow cover mapping)
Ka-Band	27 GHz – 47 GHz	high resolution radars



Radar images

Image in C-band

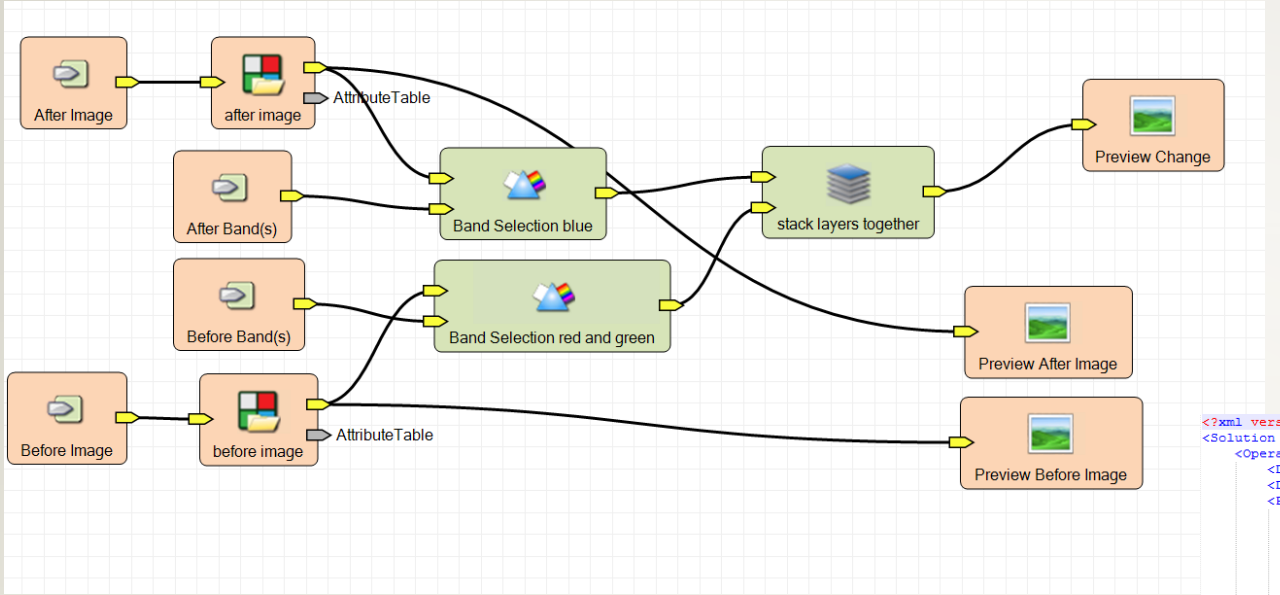
Image in L-band



soil moisture

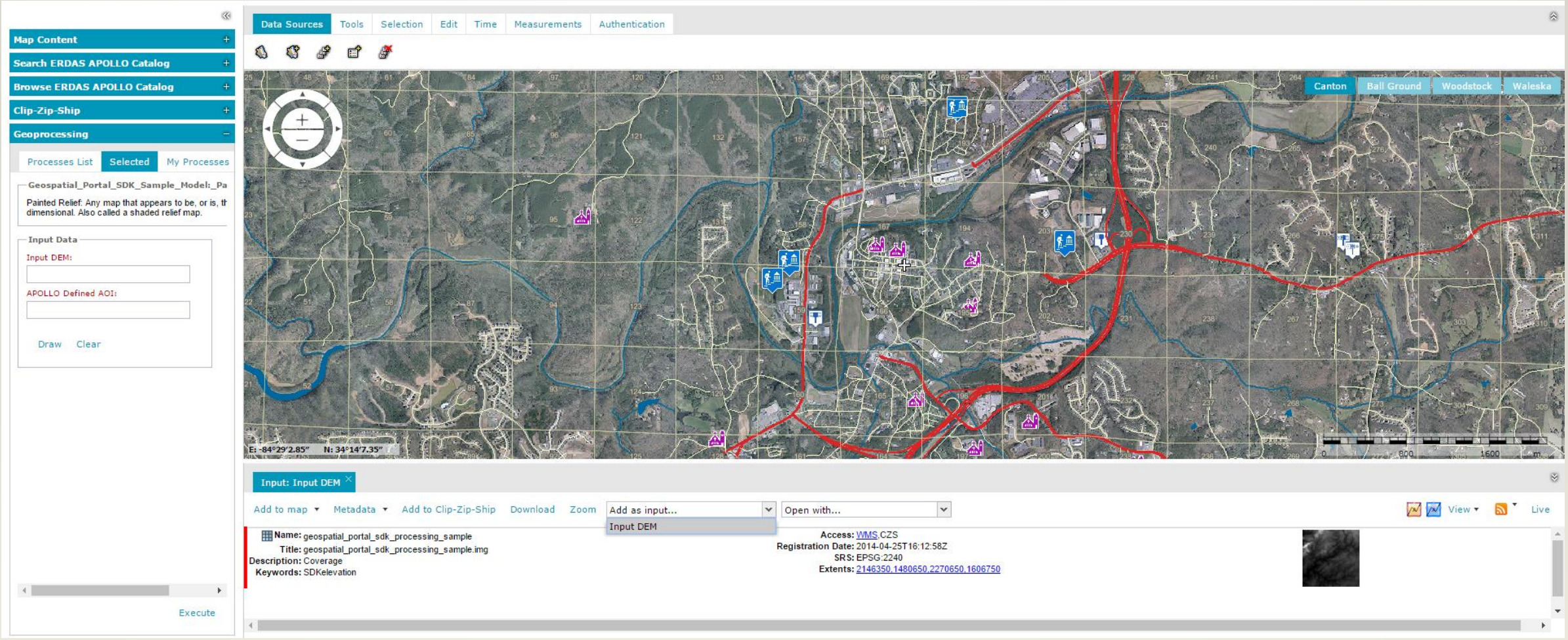
Data analysis and visualization

Spatial Modelling

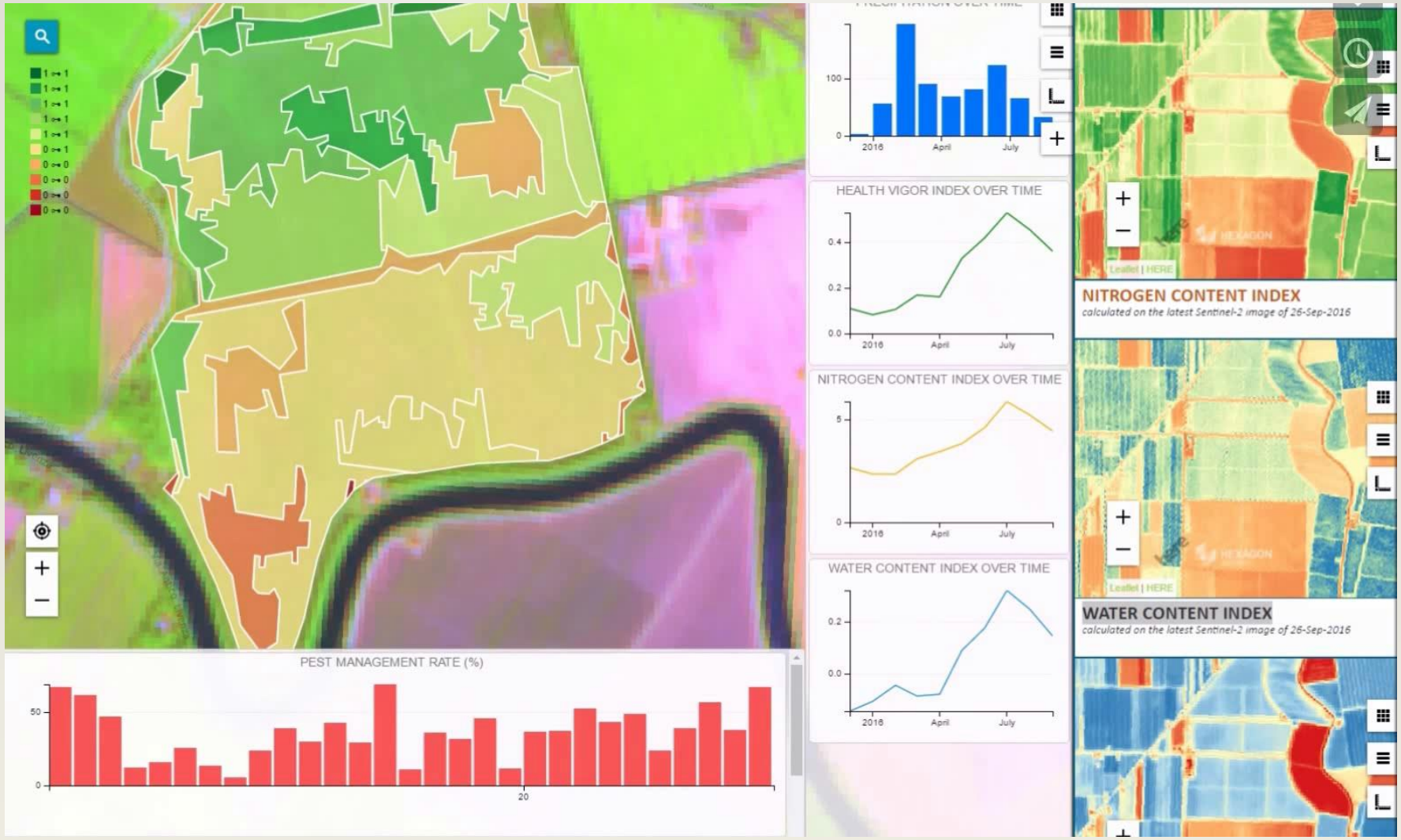



```xml
<?xml version="1.0" encoding="UTF-8"?>
<Solution xmlns="http://tempuri.org/XMLSchema.xsd">
    <Operator Namespace="IMAGINE" Name="Process">
        <DisplayName>NDVI Categorised</DisplayName>
        <Description>Produces a six class dataset based on NDVI values from an input with NIR and Red bands</Description>
        <Port Name="Port Input 2">
            <DisplayName>Output File</DisplayName>
            <Description>Select file name of output categorised NDVI file</Description>
            <Input>true</Input>
            <Output>false</Output>
            <Hidden>false</Hidden>
            <Optional>false</Optional>
            <Data>
                <StringValue>c:/data/agro/agroosnova/images/landsat_vs_rapideye/june_2015_rapideye_ndvi_re_categor.img</StringValue>
                <Type Namespace="IMAGINE" Name="File"/>
            </Data>
            <Attribute Name="AdditionalTypes">
                <Data>
                    <StringValue>{&quot;StringList&quot;:[&quot;IMAGINE.File&quot;]}
</StringValue>
                    <Type Namespace="IMAGINE" Name="StringList"/>
                </Data>
            </Attribute>
            <Attribute Name="Keywords">
                <Data>
                    <StringValue></StringValue>
                    <Type Namespace="IMAGINE" Name="String"/>
                </Data>
            </Attribute>
            <Attribute Name="Orientation">
                <Data>
                    <StringValue>0</StringValue>
                    <Type Namespace="IMAGINE" Name="Int"/>
                </Data>
            </Attribute>
            <Attribute Name="PositionX">
                <Data>
                    <StringValue>1024</StringValue>
                    <Type Namespace="IMAGINE" Name="Int"/>
                </Data>
            </Attribute>
```

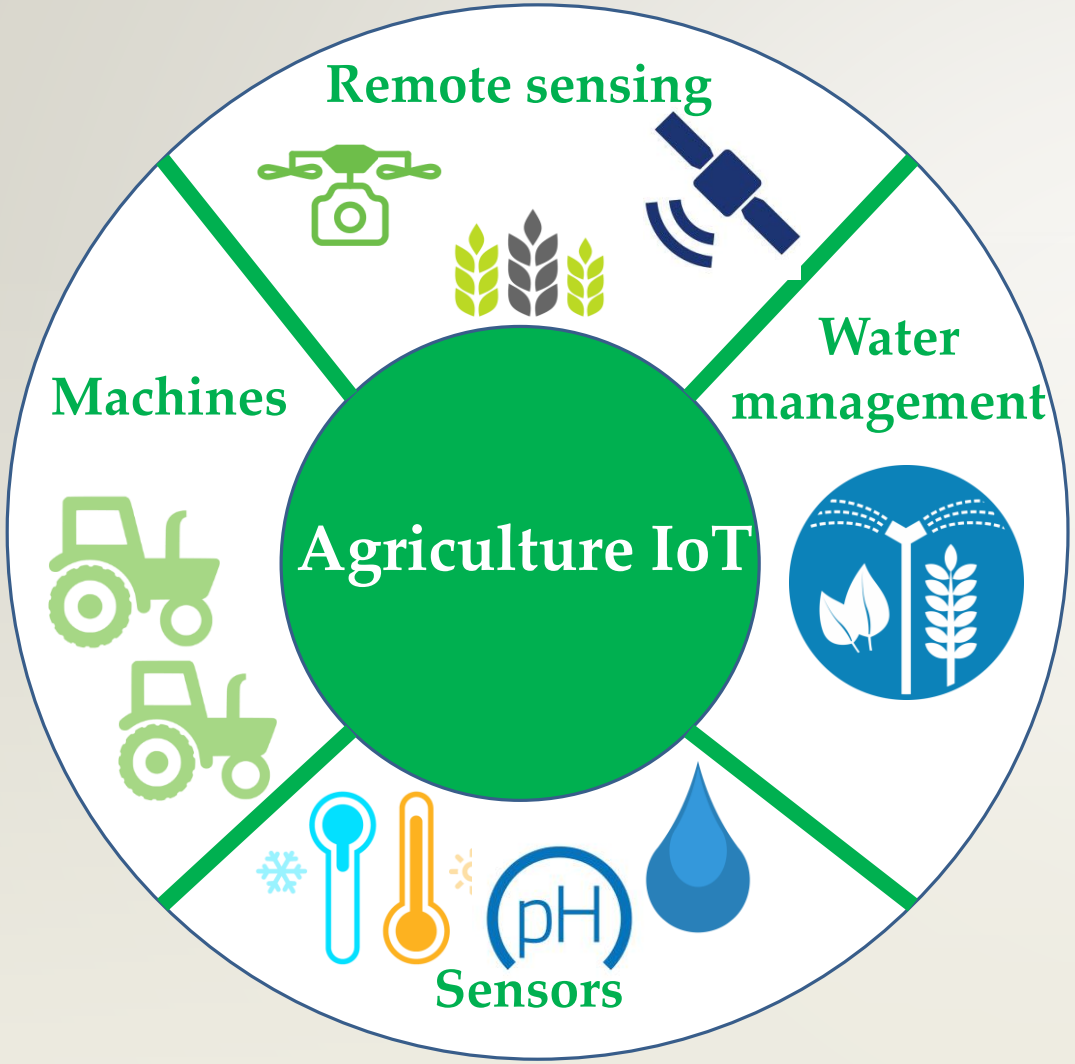
Spatial Modelling

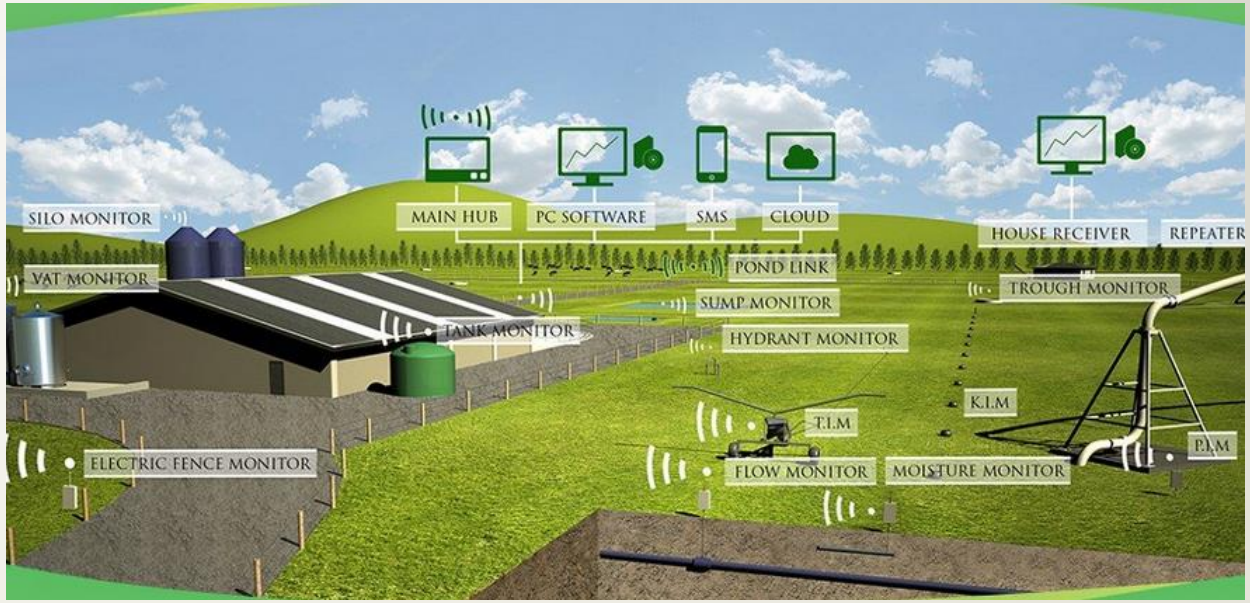


Analysis Report



Internet of Thing in agriculture



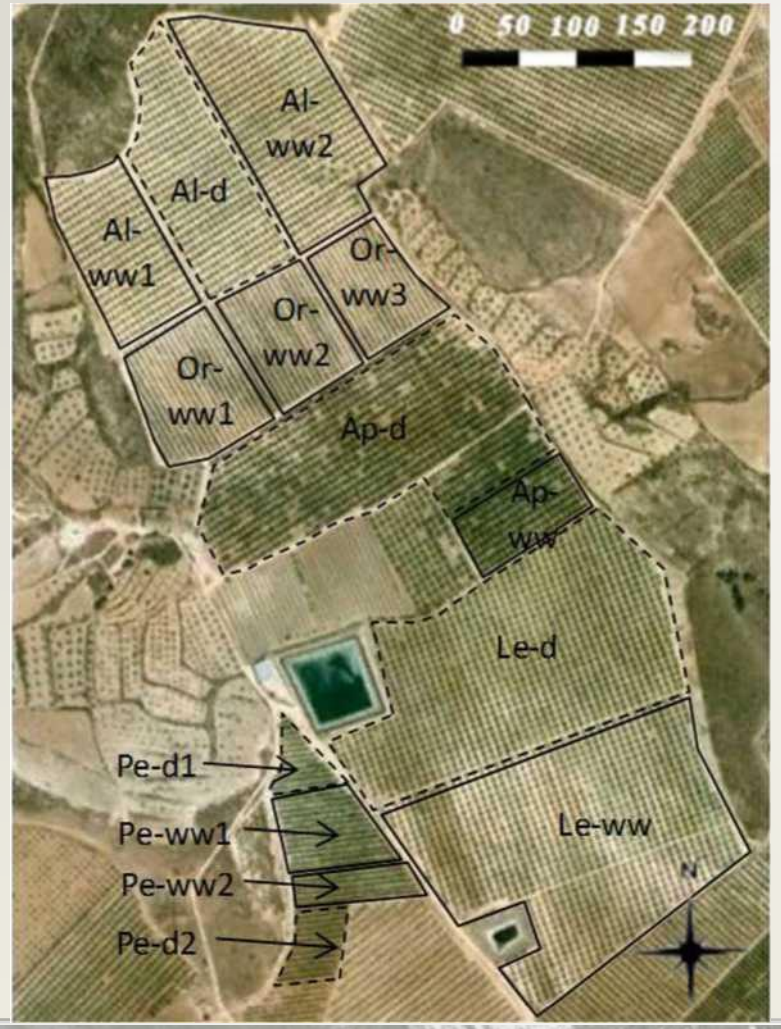


Internet of Thing in agriculture

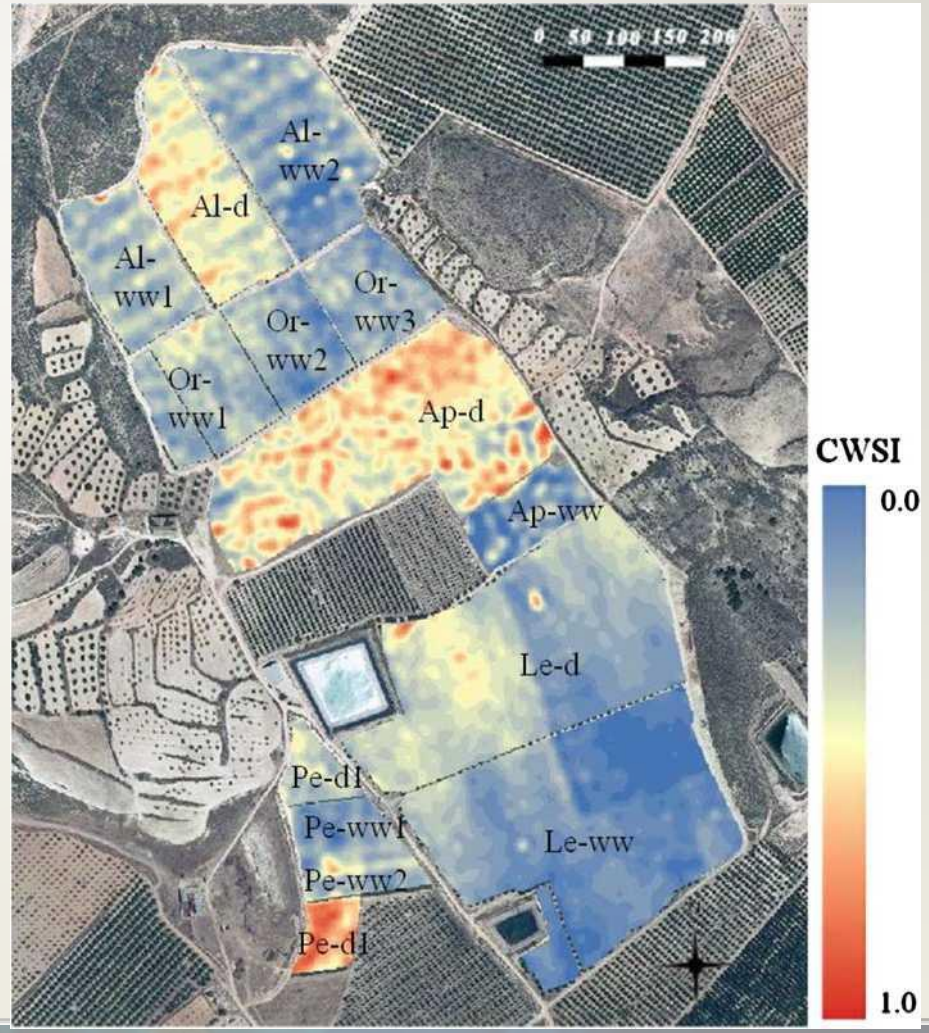
Projects and case studies

Using thermal imagery

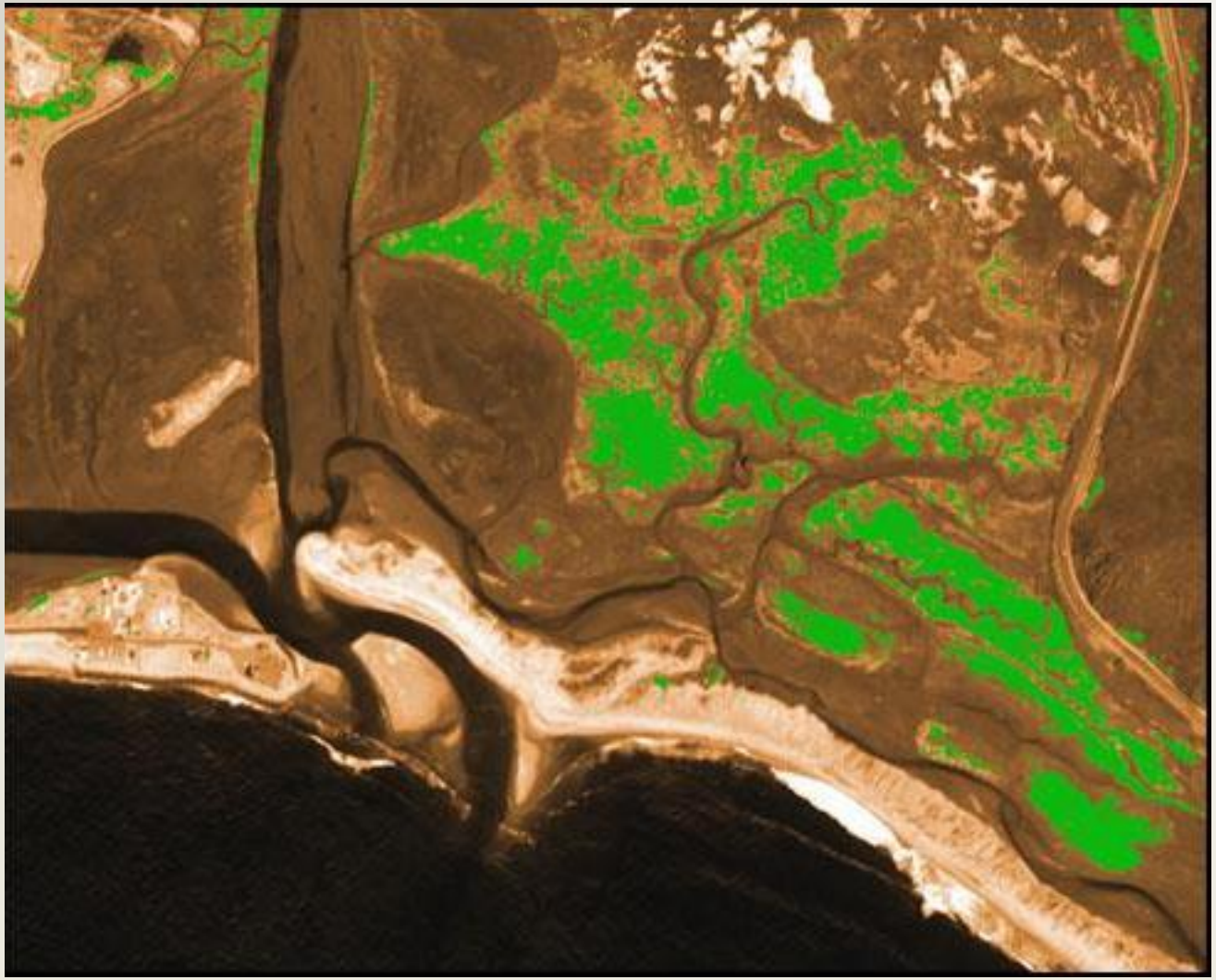
Aerial view of the orchard and its irrigation management units

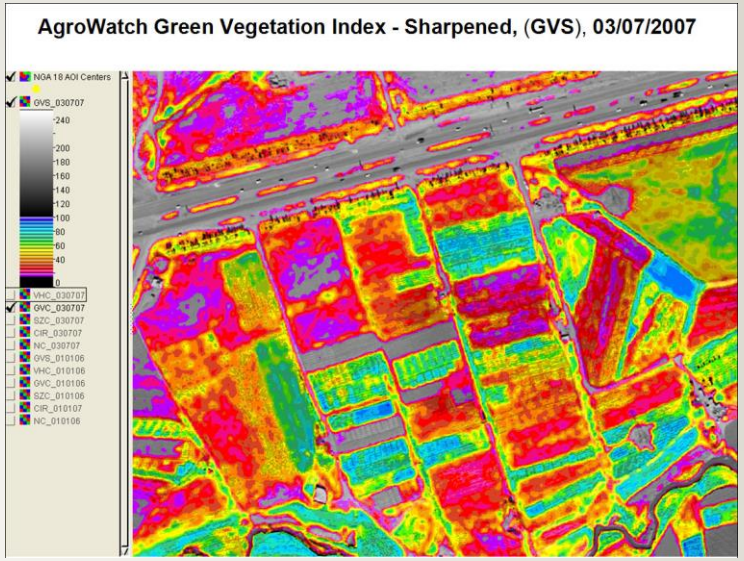


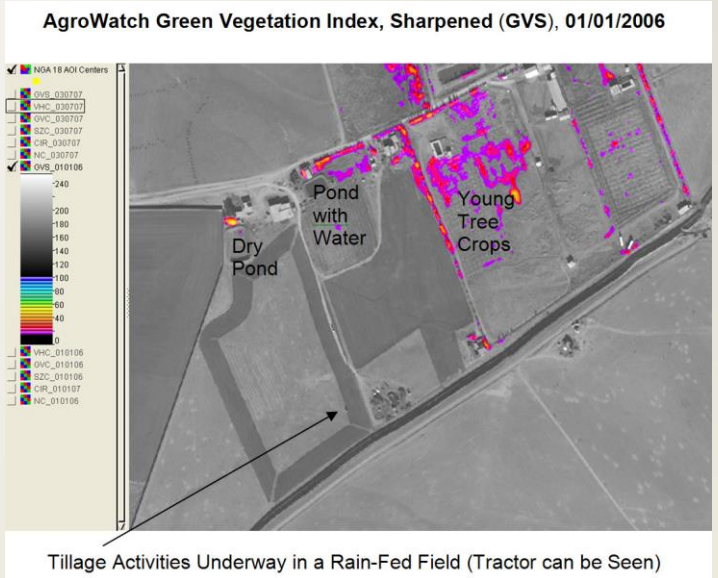
Map of the Crop Water Stress Index (CWSI), showing the scale from minimum to maximum CWSI



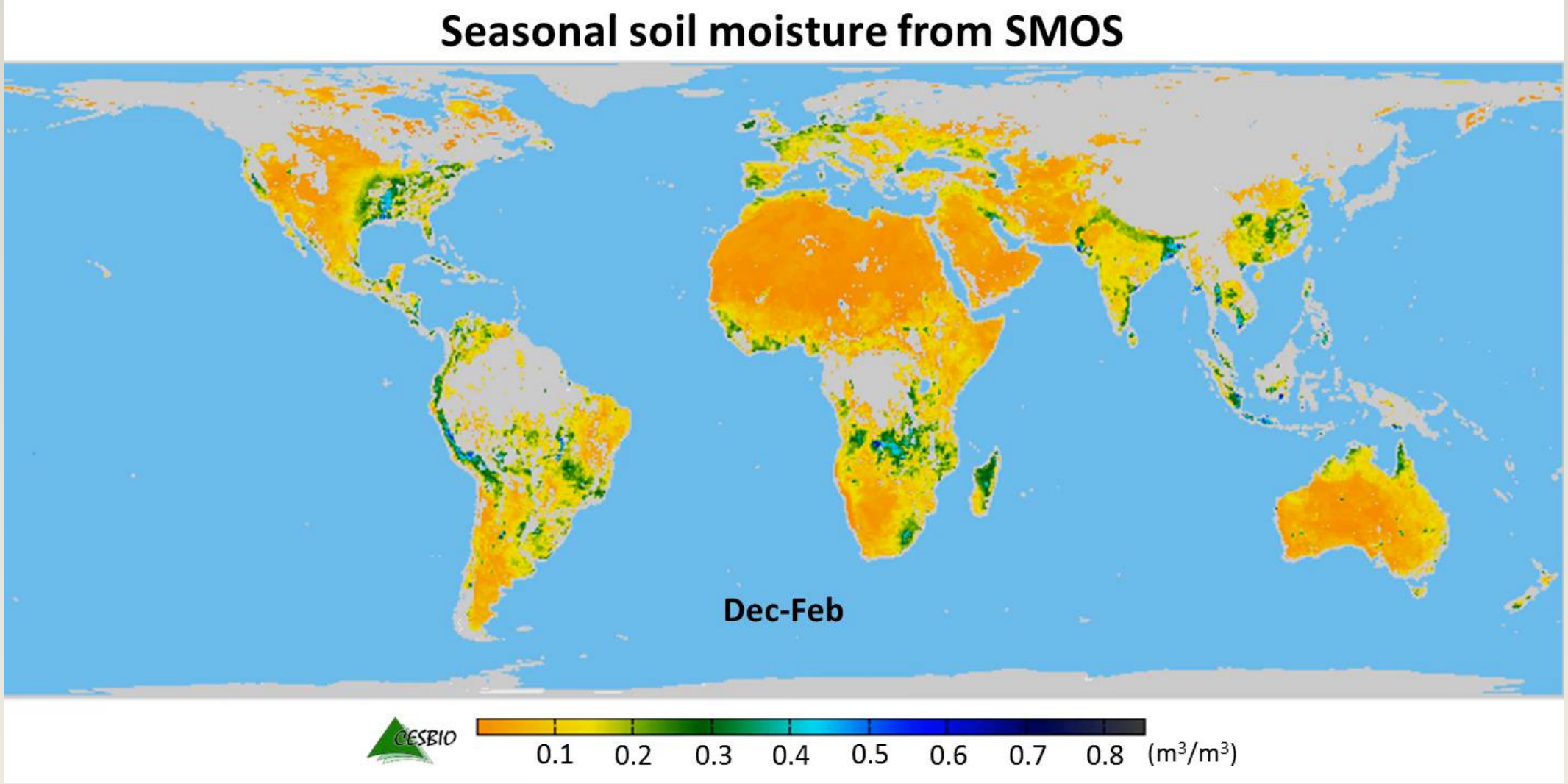
AgroWatch



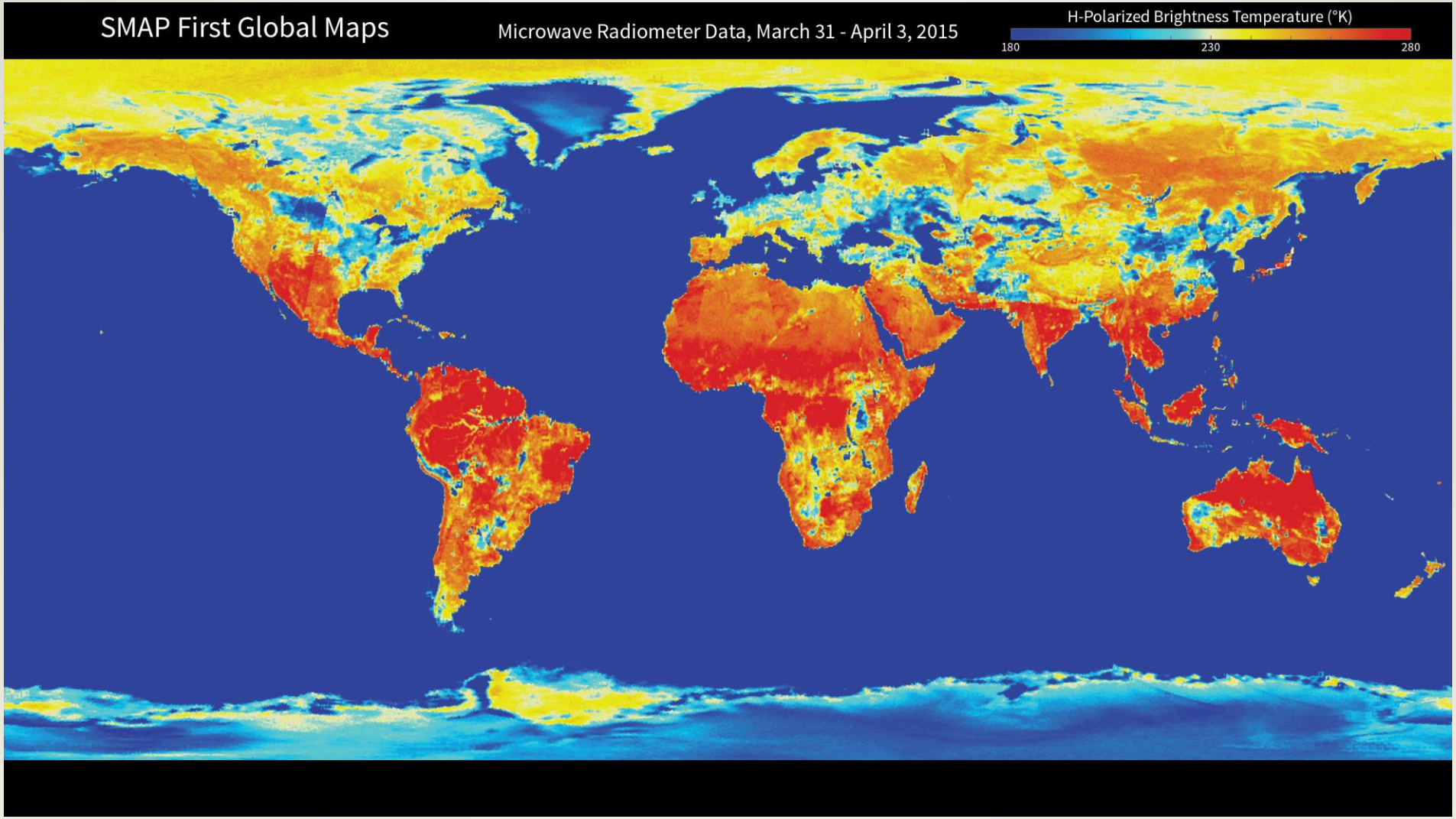

AgroWatch Green Vegetation Index - Sharpened, (GVS), 03/07/2007
NGA 18 AOI Centers
GVS_030707
240
200
180
160
140
120
100
80
60
40
0
VHC_030707
GVC_030707
SZC_030707
CIR_030707
NC_030707
GVS_010106
VHC_010106
GVC_010106
SZC_010106
CIR_010107
NC_010106


AgroWatch Green Vegetation Index, Sharpened (GVS), 01/01/2006
NGA 18 AOI Centers
GVS_030707
VHC_030707
GVC_030707
SZC_030707
CIR_030707
NC_030707
GVS_010106
240
200
180
160
140
120
100
80
60
40
0
VHC_010106
GVC_010106
SZC_010106
CIR_010107
NC_010106
Dry Pond
Pond with Water
Young Tree Crops
Tillage Activities Underway in a Rain-Fed Field (Tractor can be Seen)

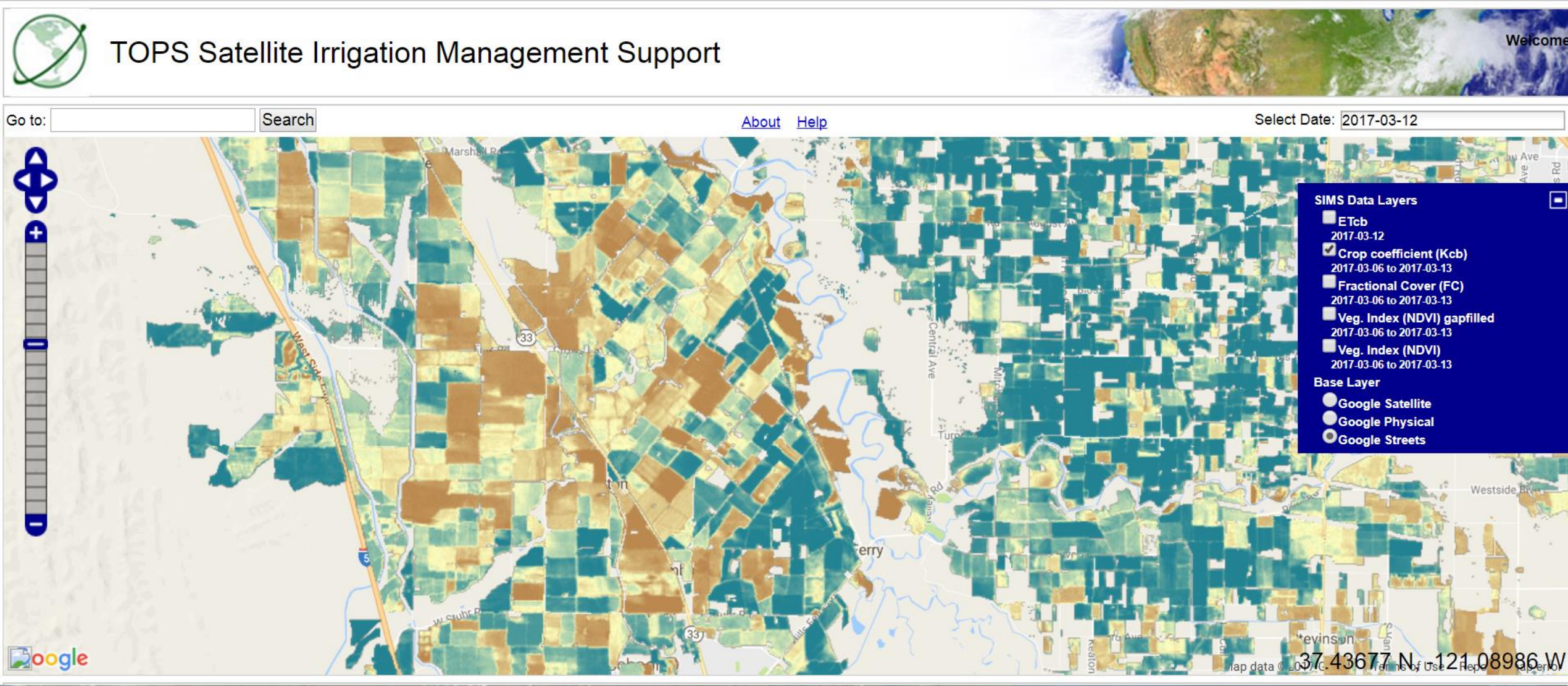
Soil Moisture and Ocean Salinity (SMOS)



Soil Moisture Active Passive (SMAP)



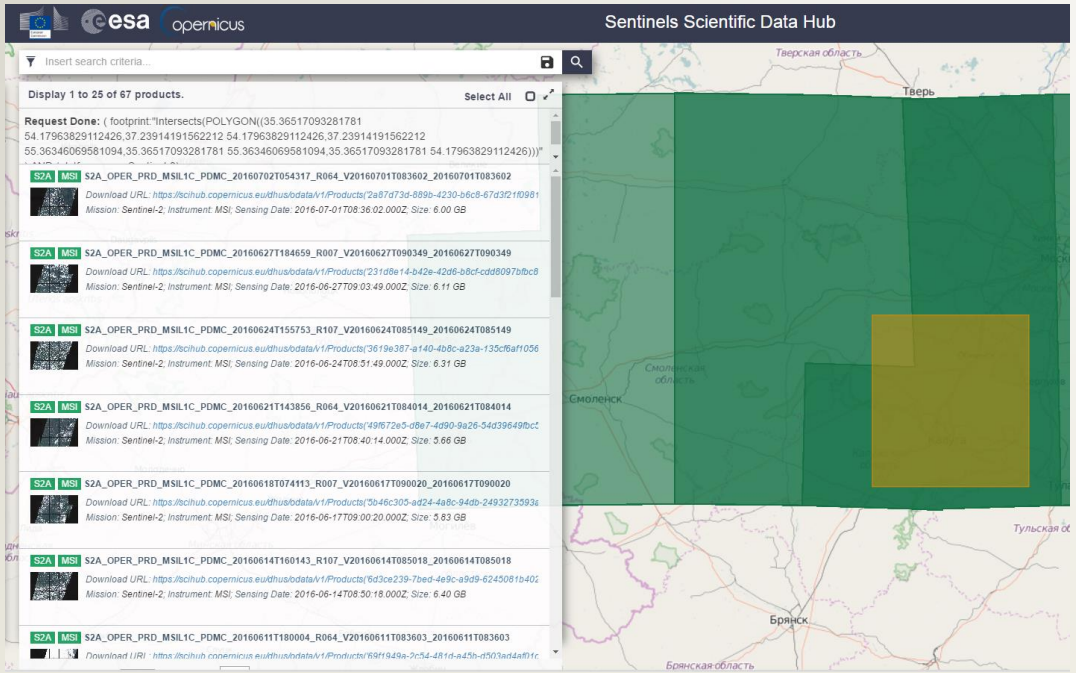
Satellite Irrigation Management Support with the Terrestrial Observation and Prediction System



Water content assessment

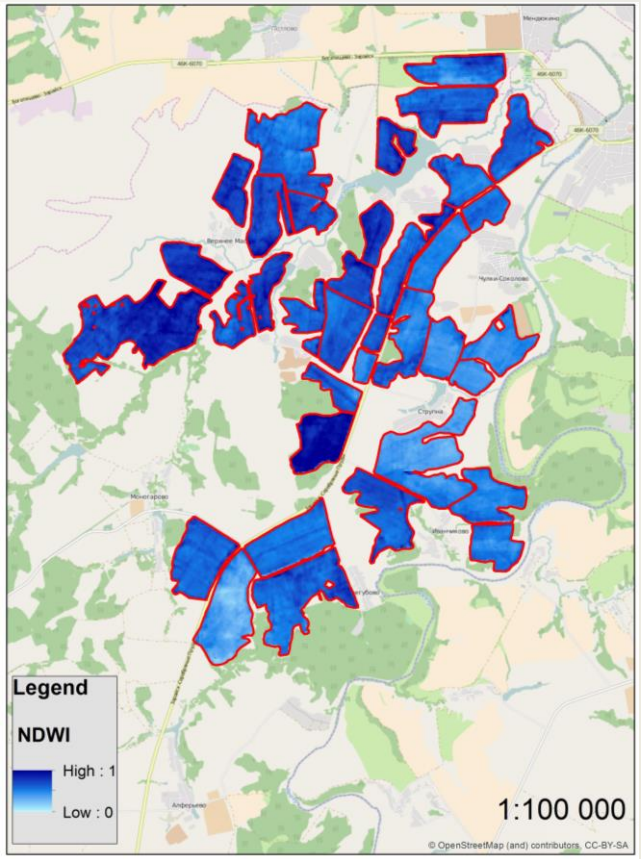
Data: Sentinel – 2

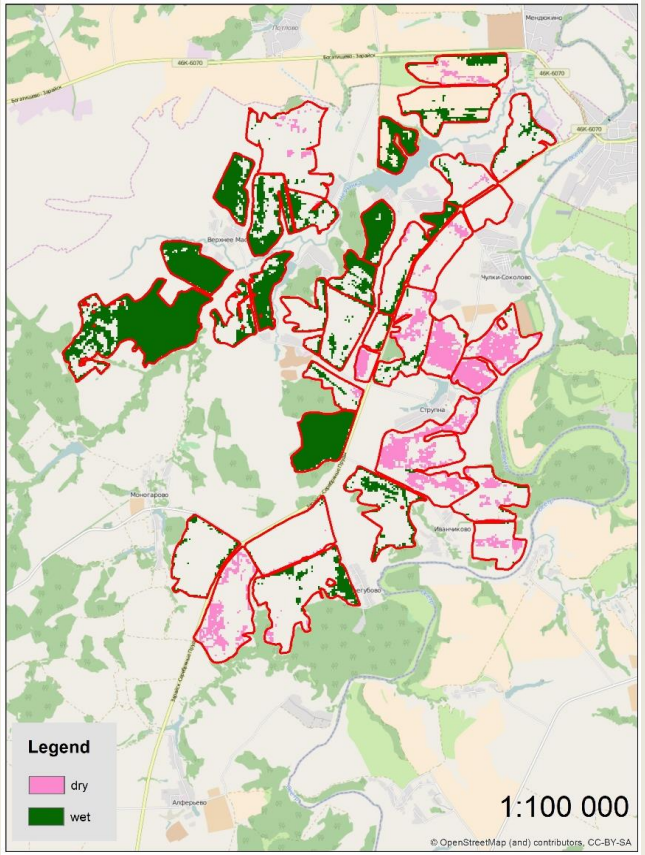
Source: https://scihub.copernicus.eu/dhus/#/home
or using QGIS plugin



Based on: The Normalized Difference Water Index (NDWI)

Expression: (NIR - MidIR) / (NIR - MidIR)





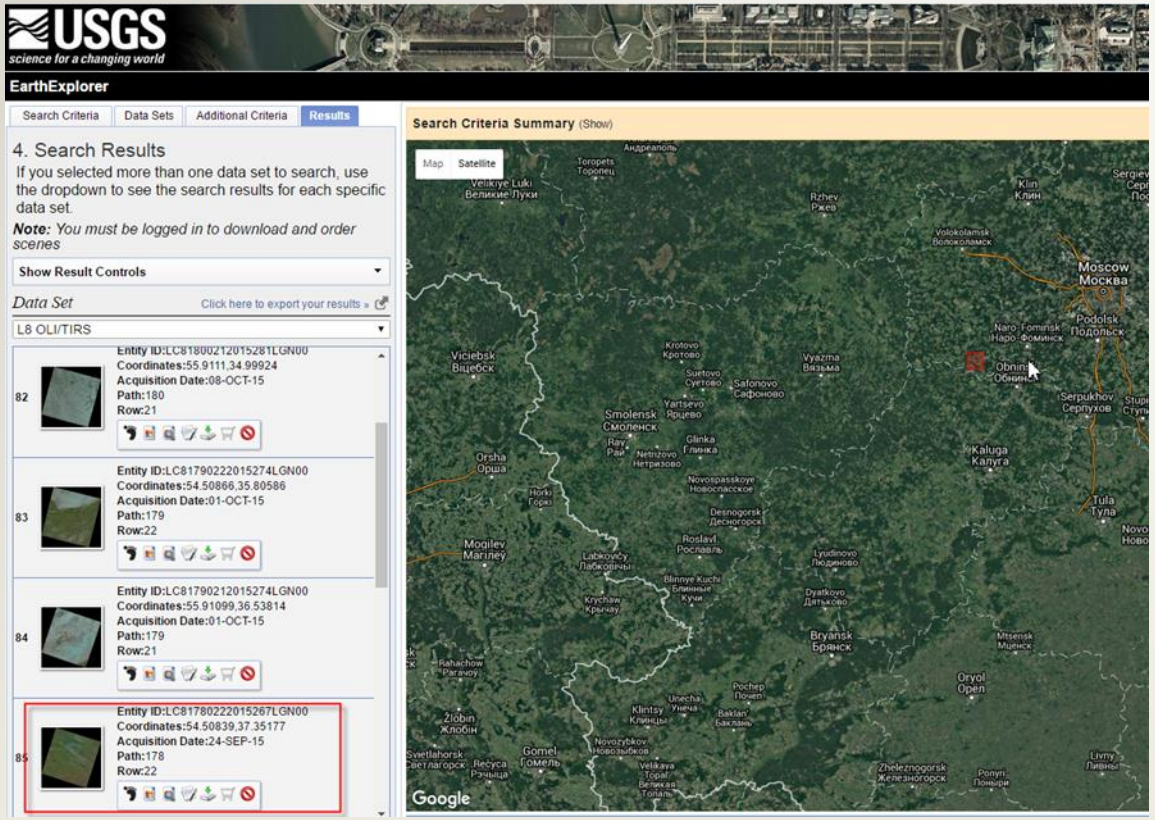
Overgrown area detection

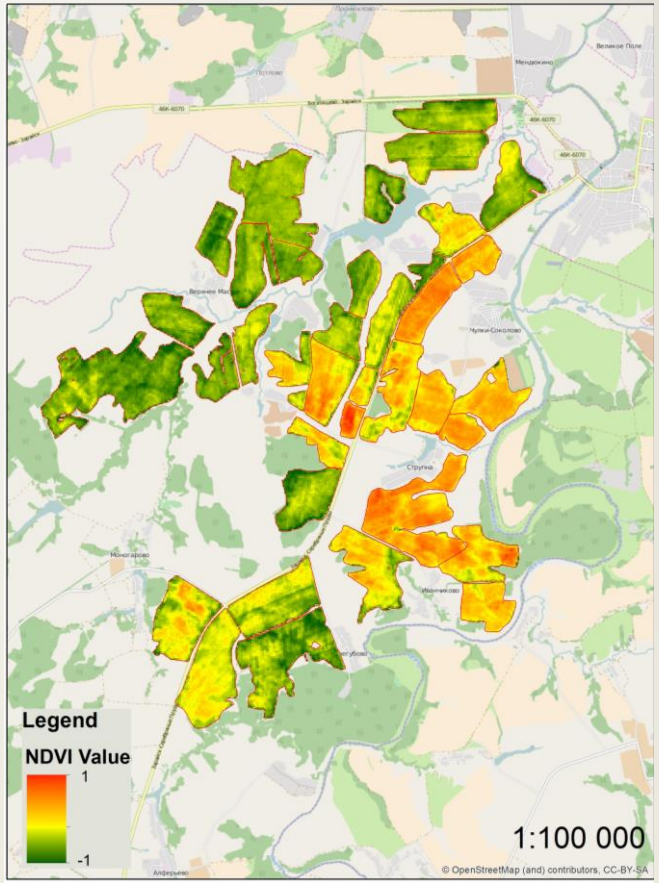
Data: Landsat – 8

Source: http://earthexplorer.usgs.gov/

Based on: NDVI index

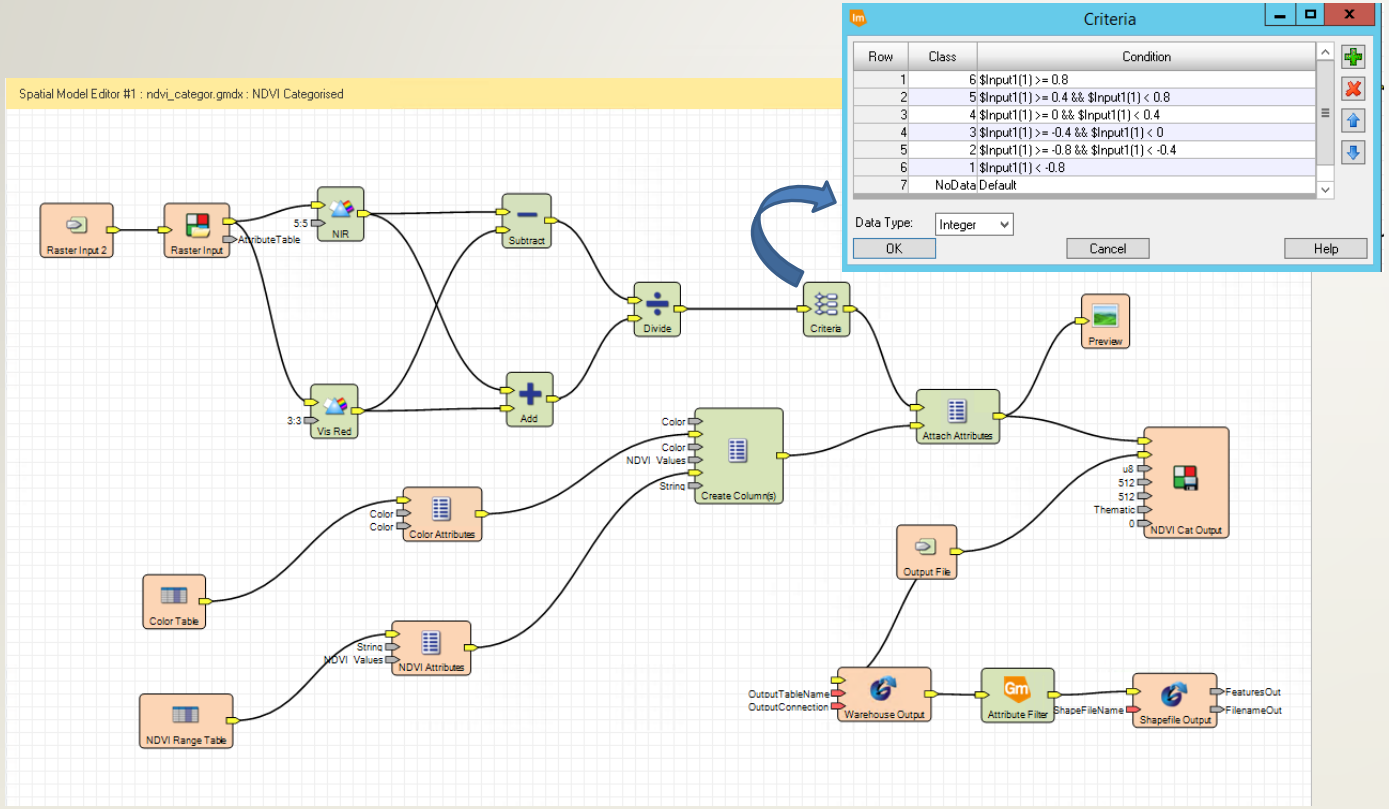
Expression: (NIR – Red)/(NIR + Red)



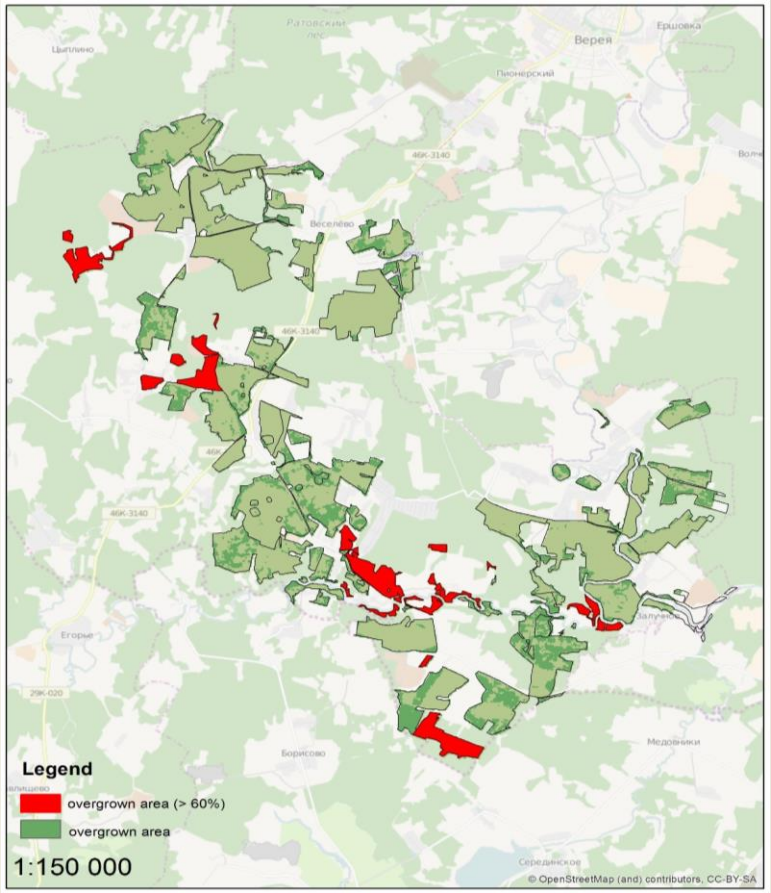


Overgrown area detection

Spatial model for index calculation and overgrown area detection



Overgrown crop parcels



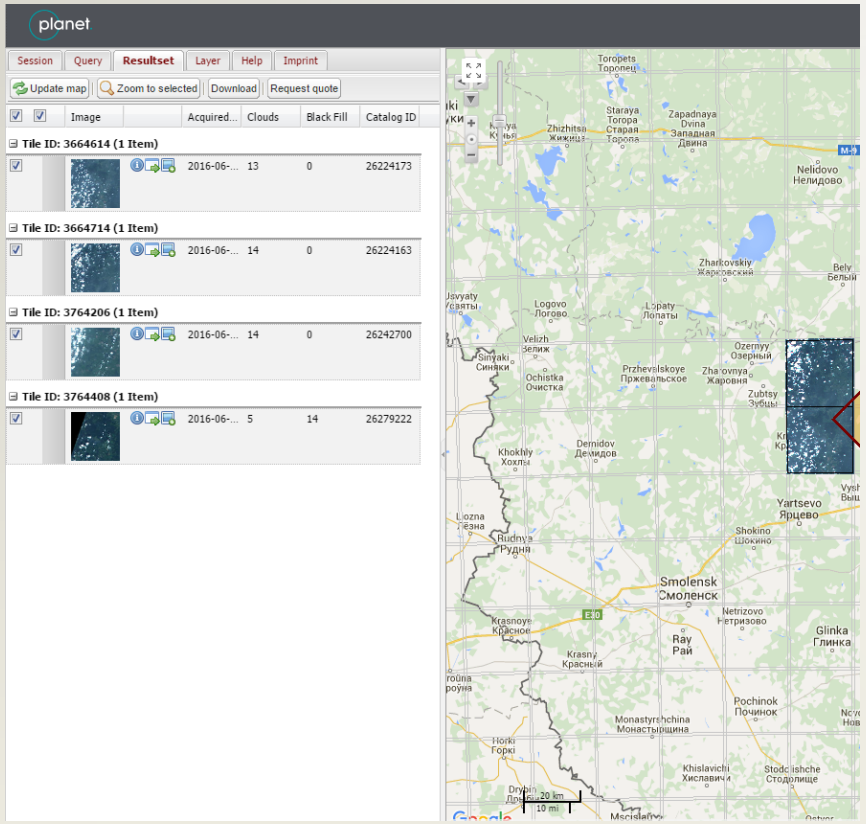
Chlorophyll content assessment

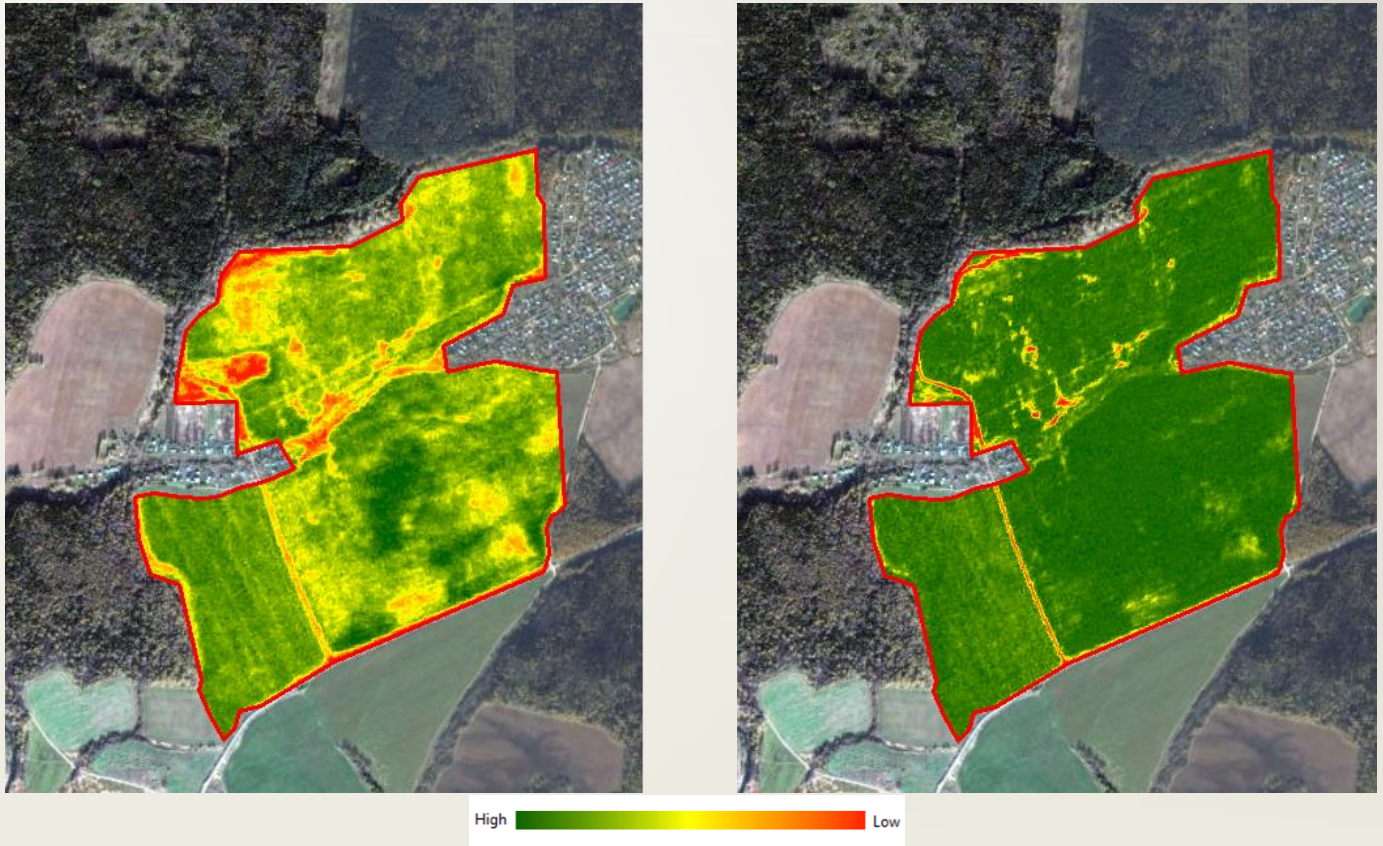
Data: RapidEye

Source: http://eyefind.rapideye.com/

Based on: Improved Modified Chlorophyll Absorption Ratio Index (MCARI)

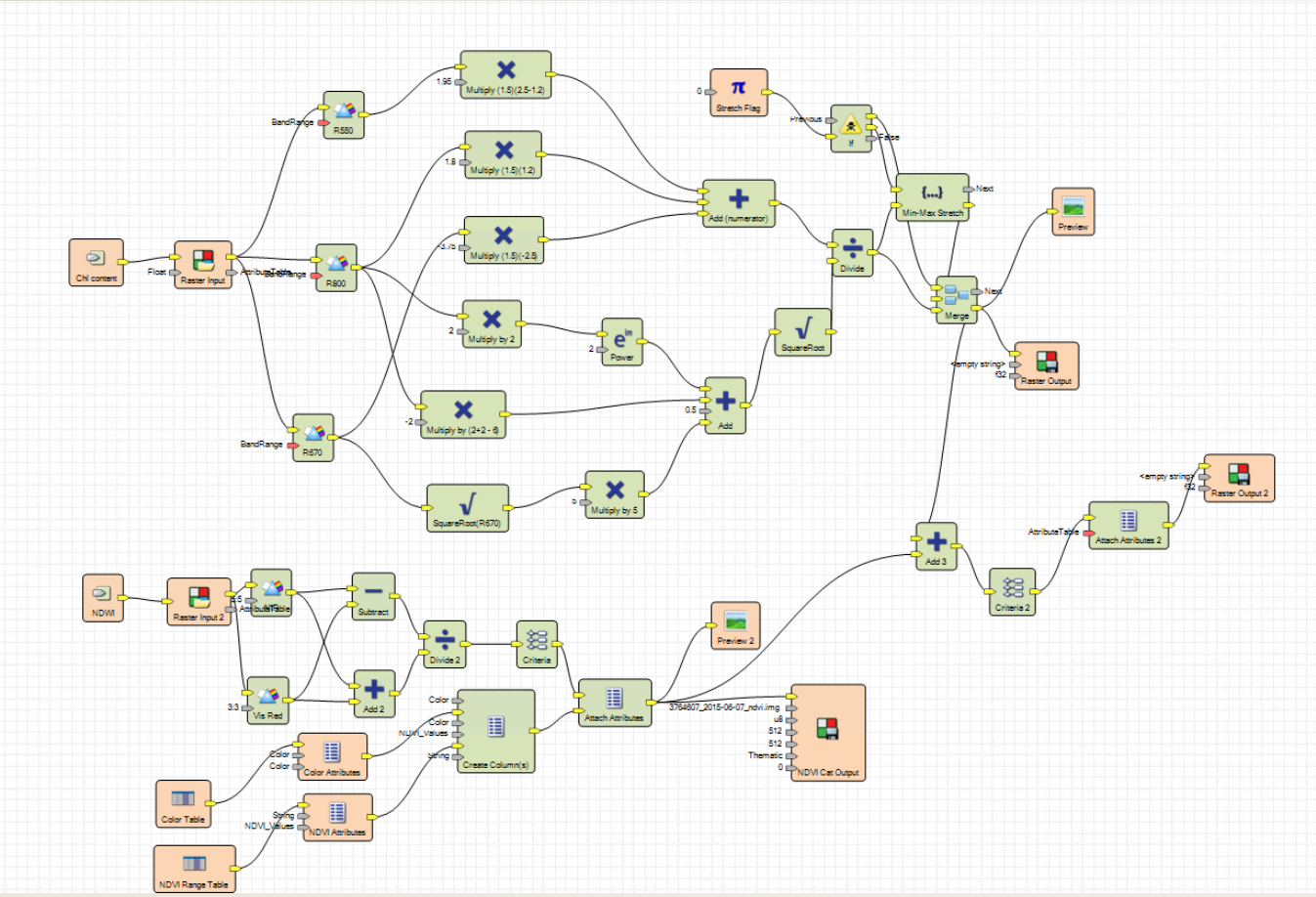
Expression: (1.5*(2.5(NIR – RedEdge) – 1.3(NIR – Green)))/SQRT((2*NIR + 1)^2 – (6*NIR – 5*SQRT(RedEdge)) – 0.5

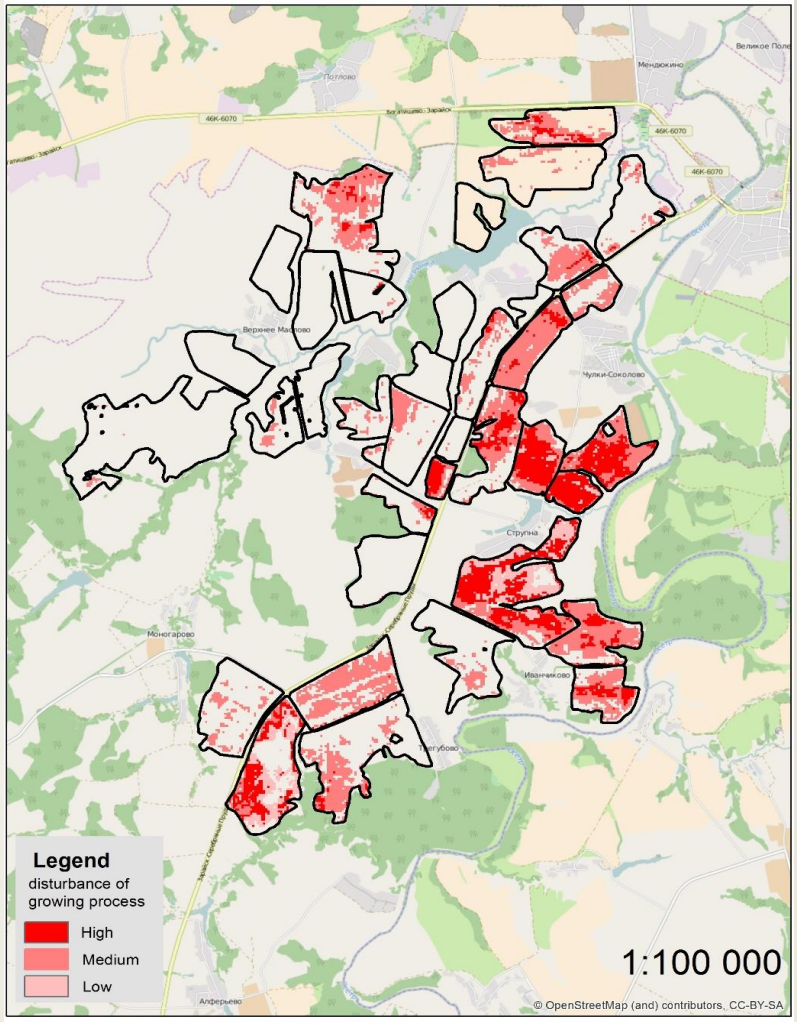




Relative chlorophyll maps. May and June, 2015

Identification of problematic crop parcels





THANK YOU

es.khazieva@gmail.com